Predicting ambulation status one year after lower extremity bypass

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Introduction: **Surgeons must weigh the morbidity of lower extremity bypass (LEB) with the likelihood of a functional outcome postoperatively. We developed a model to predict ambulation status 1 year after LEB.**

Methods: **We analyzed a prospective registry of 1561 LEB procedures performed for occlusive disease (2003-2005) in 1400 patients (50 surgeons, 11 hospitals). Ambulation status was assessed preoperatively, at discharge, and at 1-year by life-table analysis. Cox proportional hazards models were used to determine predictors of ambulation status 1 year postoperatively.**

Results: **The indication for surgery was claudication in 25% and critical limb ischemia (CLI) in 75%. Claudicant patients had higher primary (79% vs 73%, $P < .001$) and secondary (87% vs 81%, $P < .001$) graft patency rates and were more likely to be alive and ambulatory 1 year postoperatively (96% vs 81%, $P < .001$) than CLI patients. Amputation rates were 12% for CLI patients and 1% for claudicant patients ($P < .001$). All claudicant patients walked before surgery, and the 95% who survived 1 year postoperatively remained ambulatory. Preoperatively, 93% of CLI patients were ambulatory, and 88% of the survivors at 1 year remained ambulatory. The risk of dying or being nonambulatory 1 year postoperatively was increased in patients who were nonambulatory preoperatively (hazard ratio [HR], 1.5; 95% confidence interval [CI], 1.3-1.6; $P < .0001$), by increasing age of 70-79 (HR, 1.8; 95% CI, 1.2-2.6; $P < .007$) and 80-89 years (HR, 2.3; 95% CI, 1.5-3.7; $P < .0001$), by CLI (HR, 2.0; 95% CI, 1.2-3.4; $P < .007$), by postoperative myocardial infarction (HR, 2.5; 95% CI, 1.6-4.1; $P < .001$), and by major amputation (HR, 2.9; 95% CI, 2.1-4.1; $P < .001$). Graft thrombosis during follow-up (HR, 1.6; 95% CI, 1.1-1.8; $P < .003$) and living in a nursing home preoperatively (HR, 3.5; 95% CI, 1.5-7.8; $P < .003$) were independently associated with a higher risk of being nonambulatory at 1 year.**

Conclusions: **Ambulatory and independent living status are well preserved after LEB. Risk factors of age, preoperative ambulatory ability, independent living status, CLI, graft patency, and amputation help to predict ambulatory status 1 year postoperatively. The likelihood of death or nonambulatory status at 1 year was <5% in patients with none of these risk factors to nearly 50% in patients with three or more risk factors. These variables can be used to inform decision making about whether patients should undergo LEB. (J Vasc Surg 2009;49:1431-9.)**

The ability to walk is a major determinant of independent living status among elderly individuals,[1-3] and loss of this critical skill often forces elderly patients toward nursing home admission, either temporarily or permanently.[2] Although several investigators have shown that intermittent claudication[4-8] or an abnormal ankle-brachial index (ABI)[9] predict cardiovascular death, nonambulatory status is an equally good[10] if not better[11] predictor of a morbid cardiovascular event. When ambulation status is threatened by critical limb ischemia (CLI), either from rest pain or tissue loss, the main therapy is revascularization, which is traditionally performed in open surgical fashion as a lower extremity bypass (LEB).

Many investigators have extensively studied the risk factors that predict graft patency, limb salvage, or death, but few have investigated the predictors of ambulation after LEB. Further, despite its considerable affect on function and independent living status, few investigators have examined the ability of LEB to preserve ambulation and independent living status.[12-14] Therefore, the purpose of this study was to further refine our ability to predict preoperatively which patients will be ambulatory 1 year after LEB, across community and academic centers, using our regional quality improvement database.

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METHODS

Patients and databases. We used data collected prospectively by the Vascular Study Group of Northern New England (VSGNNE), a regional cooperative quality-improvement initiative developed in 2002, to study regional outcomes in vascular surgery. Further details on this registry have been published previously[15] and are available at www.vsgnne.org. The Institutional Review Board at Dartmouth Medical School reviewed and approved the study protocol.

We included only patients who underwent open infrainguinal bypass procedures for occlusive disease. Bypass inflow could be iliac, femoral, or popliteal arteries. Bypass targets could be above knee or below knee, popliteal, tibial, or pedal vessels. The analysis also included patients with concomitant endovascular procedures such as iliac stenting at the time of LEB. LEB procedures could be performed in an in situ fashion, with reversed vein, with vein cuffs or adjuncts, or with prosthetic conduit.

Our unit of analysis was the patient, and the main outcome measure was the ability to walk at 1 year after LEB. We identified 1400 patients in our database who underwent 1561 LEB procedures between January 1, 2003, and December 31, 2006. In patients with multiple LEBs on the ipsilateral or contralateral extremity, we analyzed only the initial LEB procedure and measured the main outcome measure at 1 year after the initial LEB procedure; we did not analyze the 102 (5%) subsequent ipsilateral or contralateral LEB procedures. Among these subsequent procedures, 21% were a second bypass on the same limb, whereas 79% were a bypass on the contralateral extremity. Among the remaining 1400 patients, long-term follow-up was not available in 215 patients (11% of the total), and 176 (13%) had died <1 year.

Definitions. Patients were evaluated for pre-existing medical comorbidities, and these data were prospectively entered into our registry by trained personnel. Comorbidities included chronic obstructive pulmonary disease (medical history), congestive heart failure (medical history or documented ejection fraction <50% on preoperative testing), coronary artery disease (history of angina, myocardial infarction [MI], prior coronary intervention, or electrocardiography changes consistent with previous MI), chronic renal insufficiency (creatinine ≥1.8 mg/dL), end-stage renal disease (on dialysis), diabetes mellitus (medical history, designated as diet-controlled, on oral hypoglycemic agents, or on insulin), hypertension (chart history or blood pressure ≥140/90), hyperlipidemia (documented by chart medical), and prior lower extremity bypass or endovascular therapy.

Functional status was determined preoperatively, at the postsurgical discharge, and again at 1 year postoperatively. Ambulation status was categorized as independently ambulatory, ambulatory with assistance such as a cane or a walker, wheelchair-bound, or bedridden. For modeling purposes, we collapsed these four categories into two, defining ambulatory as either independently ambulatory or ambulating with assistance. Nonambulatory patients were in a wheelchair or bedridden. We determined the preoperative living situation (home or nursing home), the indication for surgery (asymptomatic, claudication, rest pain, tissue loss, acute ischemia), and the discharge destination (home or nursing home). ABIs were recorded. Prior bypass or endovascular intervention, either preoperatively or concomitantly, was recorded, as was prior ipsilateral or contralateral amputation. Ipsilateral major amputation did not preclude the "ambulatory" designation 1 year after surgery if a patient walked successfully with a prosthesis.

Data collection. Trained nurses or clinical data abstractors entered data prospectively on >70 clinical and demographic variables (available at www.vsgnne.org). Research analysts were blinded to patient, surgeon, and hospital identity. A current version of the Social Security Death Index and 1-year follow-up data obtained as part of VSGNNE were used to confirm the survival status of all patients during the first year after LEB.

Risk model construction. Our main outcome measure was the patient's ability to ambulate, with or without assistance, 1 year after surgery. We used life-table analysis because not all follow-up data were obtained at exactly 1 year and to account for deaths within 1 year. Ambulation rate was then calculated by life-table analysis, expressed as the proportion surviving and ambulatory, either independently or with assistance.

In univariate analysis, we first selected potential preoperative risk factors based on clinical judgment and previous publications and compared each variable with the 1-year ambulatory status. Risk factors found by univariate analysis to be associated with value of $P < .1$ were then used in a multivariate Cox proportional hazards model. This model was used to calculate hazard ratios (HR) and 95% confidence intervals (CI) for ability to ambulate 1 year after surgery.

Cox-Snell residuals were used to predict 1-year ambulatory status by each patient's risk factor profile. The predictive ability of each model was evaluated by generating an observed/expected outcome ratio across the range of risks identified. All analyses were performed using Excel (Microsoft, Redmond, Wash) and STATA software (StataCorp, College Station, Tex).

RESULTS

Patient characteristics. Between January 1, 2003, and December 31, 2006, 1400 patients underwent LEB at one of the 11 centers participating in the registry. Patients were most commonly white men, aged 70 to 80 years, who were former or current smokers. Risk factors were typical for such patients (Table I). Indication for surgery was claudication in 25, whereas the remaining patients had CLI. Most (74%) had autogenous vein conduit (Appendix, online only).

At 1 year by life-table analysis, primary graft patency was 72%, primary assisted patency was 82%, and secondary patency was 84%. Compared with patients with CLI, claudicant patients had higher primary (79% vs 73%, $P < .001$) and secondary (87% vs 81%, $P < .001$) patency rates. Among survivors, the 1-year amputation rate was 1% in claudicant patients and 12% in CLI patients ($P < .001$). Amputation rates were similar across conduit types, at 9% for autologous and 10% for prosthetic ($P = .63$).

Survival and ambulation. At 1 year postoperatively by life-table analysis, 84% of patients survived to ambulate (Fig 1), meaning that they were alive and could walk at the 1-year follow-up. Patients with claudication were significantly more likely to survive and ambulate than the CLI patients (96% vs 81%, $P < .0001$).

Ambulatory status: claudication vs CLI. All patients with claudication were ambulatory before surgery, and only

Table 1. Patient characteristics and univariate analysis of ambulatory status at 1 year

		Unable to ambulate		
Variable[a]	*Total*	*If variable not present*	*If variable present*	P
Patient characteristics				
Male gender	65%	11%	6%	.001
Not living home pre-op	2%	7%	24%	.0001
Not ambulatory pre-op	24%	3%	20%	.0001
Urgent/emergency operation	19%	6%	14%	.0001
Age 60-69	27%	9%	6%	.02
Age 70-79	32%	6%	8%	.024
Age 80-89	11%	7%	12%	.072
Age 90-99	1%	7%	10%	.016
COPD	29%	7%	10%	.034
Diabetes	53%	5%	10%	.003
Coronary disease	41%	7%	9%	.044
Congestive heart failure	17%	6%	15%	.0001
Rest pain	72%	1%	4%	.001
Tissue loss	72%	1%	11%	.0001
Concomitant ipsilateral procedure				
Proximal angioplasty	4%	7%	18%	.003
Proximal stenting	4%	8%	18%	.01
Pre-op antiplatelet use	67%	6%	8%	.096
Operative characteristics				
Common femoral origin	71%	11%	7%	.009
AK popliteal origin	4%	7%	22%	.0001
AK popliteal recipient	26%	9%	4%	.001
Pedal recipient	10%	7%	11%	.02
Conduit				
Dacron	3%	8%	0%	.067
Polytetrafluoroethylene	20%	9%	5%	.037
Other nonautologous conduit	3%	7%	23%	.001
Post-op complications				
Superficial wound infection	4%	7%	14%	.068
Return to OR (any reason)	13%	6%	18%	.00001
Return to OR (thrombosis)	10%	10%	18%	.017
Discharge variables				
Home	75%	16%	5%	.0001
Rehabilitation facility	16%	7%	11%	.036
Nursing home	9%	6%	25%	.0001
Independent ambulation	54%	13%	2%	.0001
Graft patent at long-term follow-up	68%	14%	4%	.0001
Deep wound infection	2%	7%	19%	.01

AK, Above-knee; *COPD,* chronic obstructive pulmonary disease; *OR,* operating room.
[a]Only variables with value of $P < .10$ are included; remainder are in Appendix (online only).

5% required the assistance of a cane or a walker (Fig 2, *A*). At the time of discharge, all patients remained ambulatory as well; however, 21% now required assistance with ambulation. At the 1-year follow-up, 4% of patients had died. All of the survivors with claudication were ambulatory. A similar number of patients with claudication required assistance with ambulation after surgery (4%) compared with before surgery.

Most patients with CLI were ambulatory preoperatively (Fig 2, *B*); however, compared with claudicant patients, 25% vs 5% required the assistance of a cane or a walker ($P < .001$). By the time of discharge, almost half of ambulatory patients with CLI required assistance with a cane or walker. By the 1-year follow-up, the proportion of surviving patients who were ambulatory was similar to preoperative levels (93% vs 88%, $P < .07$). Therefore, among survivors, 88% of patients with CLI remained ambulatory 1 year after surgery, slightly less than those with claudication (88% vs 96%, $P < .01$).

Living status: claudication vs CLI. As expected, nearly all (99%) claudicant patients lived at home before surgery (Fig 3, *A*). A few patients (5%) were discharged to a nursing home postoperatively. By the 1-year follow-up, however, except for those patients who died (4%), nearly all patients lived independently, similar to their preoperative living status.

A larger proportion of patients with CLI lived in a nursing home before surgery than claudicant patients (4% vs 1%, $P < .03$). Patients with CLI were more likely to be discharged to a nursing home than claudicant patients. By the 1-year follow-up, except for those patients who died, the distribution of patients between independent and dependent living was not different before surgery and 1 year later (Fig 3, *B*).

Effect of major amputation. Overall, 112 patients underwent major amputation after LEB, and most (81%) occurred after discharge from the index LEB procedure. All but two amputations occurred in patients with CLI. A thrombosed bypass graft was present in 86% of the patients who required major amputation. Major amputation (above knee or below knee) dramatically decreased the chances of ambulation at 1 year (88% in patients without amputation, 62% in patients with major amputation; $P < .001$) and living independently (96% in those patients without amputation, 74% in those patients with major amputation; $P < .001$).

Effect of secondary procedures. We found that 11% of patients required a revision of the initial bypass ≤1 year after surgery, of which 7% were operative interventions such as patch angioplasty and 4% were endovascular revision such as angioplasty. Ambulation rates at 1 year were similar, regardless of whether the patient required a graft revision (91% if no revision, 90% if revision; $P < .34$).

Next, we considered the number of patients who required a new LEB on the same extremity or on the contralateral extremity. We found that ≤1 year of the initial operation, 2% of patients (by life-table analysis) underwent a new LEB procedure on the ipsilateral leg and that 7% of patients underwent a contralateral LEB procedure. Amputation rates were lower in patients who did not require a second LEB procedure, although these differences were not statistically significant (90% vs 86%, $P < .12$). Ambulation rates at 1 year did not differ if the repeat procedure

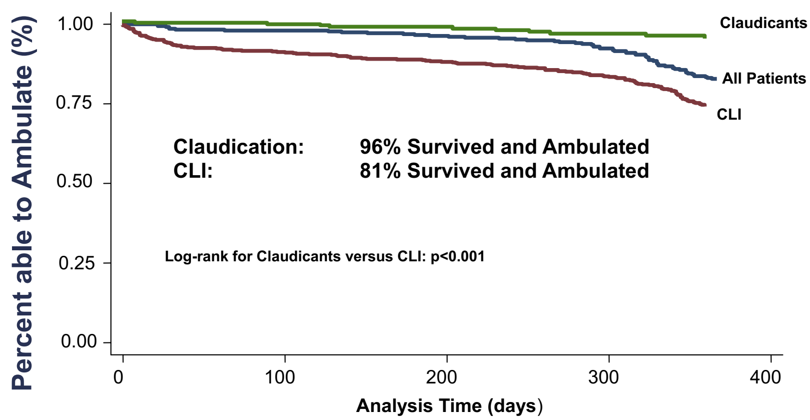

Fig 1. Survival curves for all patients undergoing lower extremity bypass, as well as by indication (claudication or critical limb ischemia [*CLI*]). Failure is defined as death or inability to ambulate.

was on the ipsilateral (87%) or contralateral extremity (84%, $P = .41$).

Prediction model for survival and ambulation at 1 year. We performed univariate comparisons between our main outcome measure (ability to survive and ambulate 1 year after surgery) and each of the variables reported in Table I. Significant relationships were observed between several variables and ambulation status. In univariate analyses, several physiologic parameters such as advanced age, diabetes, and hypertension were associated with inability to ambulate at 1 year. Also highly correlated with ambulatory status at 1 year were functional parameters such as preoperative baseline ambulatory status and living status as well as the presence of tissue loss.

In multivariate analysis, we considered preoperative and postoperative variables (Table II). Preoperatively, the risk of dying or being nonambulatory 1 year after surgery was lowest in patients who ambulated independently before surgery and highest in elderly patients and those with CLI. Postoperatively, patients who underwent major amputation or sustained a MI were more likely to die or become nonambulatory at 1 year. The likelihood of death or nonambulatory status at 1 year varied from <5% in patients with none of these risk factors to nearly 50% in patients with three or more risk factors (Fig 4).

Development of a prediction model for ambulation at 1 year. Because several of the risk factors in the model used to predict survival and ambulation at 1 year appeared to reflect overall patient survival rather than variables specifically related to ambulation, we performed a subgroup analysis of those patients who survived 1 year after surgery, excluding the 176 patients (13%) who died before the 1-year follow-up. This analysis examined the risk factors specifically related to ambulatory status. Because no patients with claudication who survived to 1 year were nonambulatory, we restricted this analysis to only those patients with CLI.

Many of the same variables had an effect, such as major amputation and preoperative functional status, and the effect size was larger for these variables when they specifically predicted ambulation status alone (Table III). Systemic conditions such as postoperative MI were no longer significant when we considered only ambulation, suggesting that these variables contributed more toward survival than ambulatory ability. Graft patency was now significant as well, supporting its importance in relation to ambulation status.

DISCUSSION

Vascular surgeons have extensively studied the factors associated with technical success after LEB grafts, especially those related to patency over time.[16-21] Less well studied are the functional outcomes of LEB, such as ambulation and independent living status. Our study of the functional results of LEB in our regional quality-improvement database identified several important risk factors associated with the ability to ambulate 1 year later.

Several groups have previously described the functional outcomes of LEB and examined risk factors predictive of subsequent ambulatory status (Table IV). Abou-Zamzam et al[22] studied ambulatory status and independent living after infrainguinal bypass in Oregon between 1980 and 1995. Their multivariate analysis confirmed the importance of preoperative independent living and ambulatory status in determining the functional outcomes of ambulation and independent living at 6 months. Their review documented that 97% of the patents who were ambulatory before surgery remained ambulatory thereafter. Of the 25 patients who were not living independently before surgery, however, only one managed to ambulate to the extent that the patient could live independently after surgery. They concluded that infrainguinal bypass performed for limb salvage is quite successful at maintaining independent living and ambulation but is not effective in restoring those qualities to patients who have already lost them.

Chung et al[23] found slightly different results. Only 72% of patients in their study were able to walk 6 months after LEB, but 91% still lived independently at that time. Their

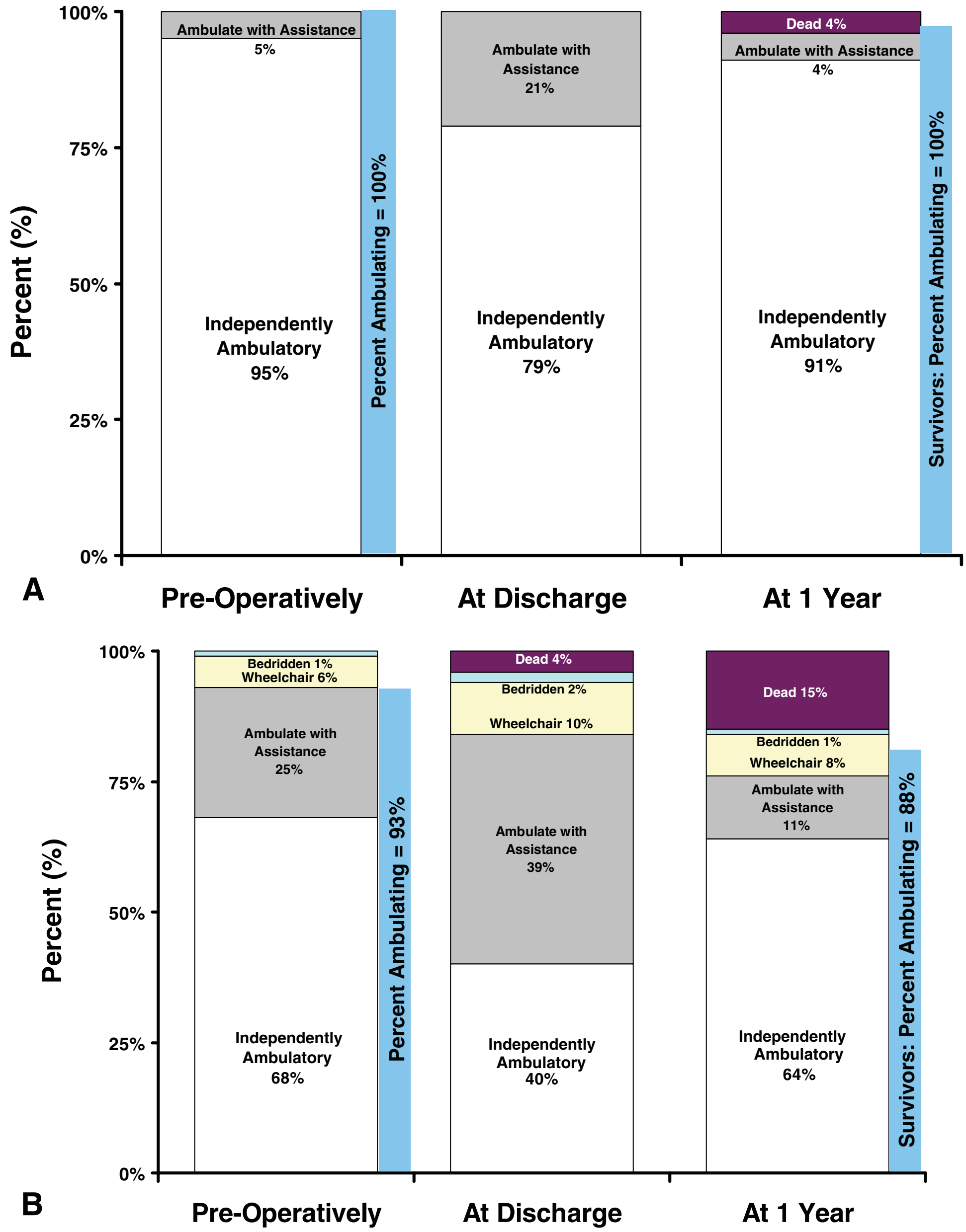

Fig 2. Ambulation status preoperatively, at discharge, and at 1 year in patients with **(A)** claudication and **(B)** critical limb ischemia.

review failed to identify any multivariate predictors of ambulation and only identified the extent of forefoot gangrene and graft patency as univariate predictors of ambulatory status.

Finally, Taylor et al[24] examined 331 patients who underwent LEB. They found that impaired ambulation at presentation, infrainguinal disease, dialysis, gangrene, and hyperlipidemia were associated with a poor composite outcome measure, of which ambulation status was a major component.

Results from the VSGNNE experience are also reported in Table IV. Our study offers insight from a large number of patients, with longitudinal examination of functional outcomes, which has allowed multivariate modeling and excellent descriptive detail in terms of the risk factors associated with loss of ambulatory status. Our rates of ambulation and independent living status are consistent with work reported previously. Across studies, preoperative ambulatory status appears in three of the four prediction models, and independent living status appears in two of the four prediction models. This emphasizes the importance of functional status before surgery in determining functional status after surgery.

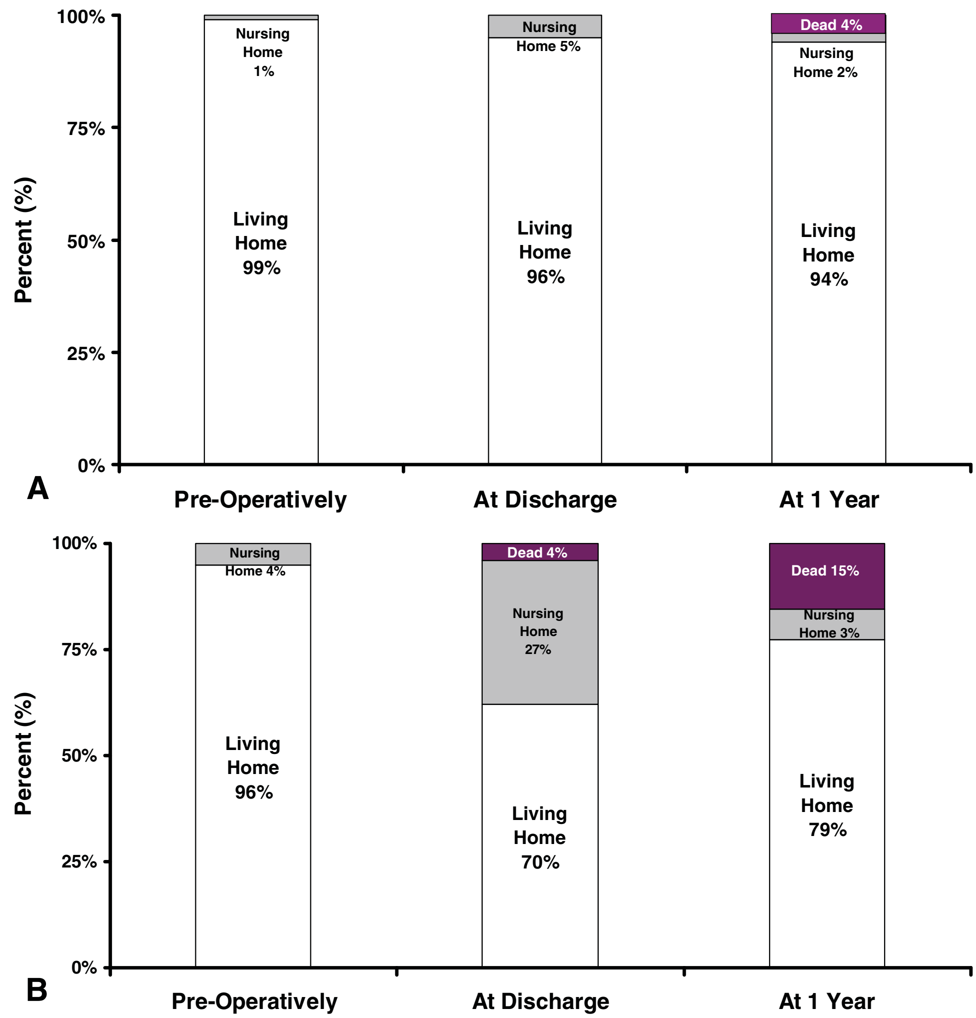

Fig 3. Living status preoperatively, at discharge, and at 1 year in patients with **(A)** claudication and **(B)** critical limb ischemia.

Table II. Multivariate predictors of death or failure to ambulate at 1 year after lower extremity bypass

Variable	*HR (95% CI)*	P
Preoperative		
Nonambulatory status[a]	1.5 (1.3-1.6)	.0001
Critical limb ischemia	2.0 (1.2-3.4)	.007
Age, y		
60-79	1.3 (0.8-2.2)	.266
70-79	1.8 (1.2-2.6)	.007
80-89	2.3 (1.5-3.7)	.0001
Postoperative		
Myocardial infarction	2.5 (1.6-4.1)	.0001
Major AK or BK amputation	2.9 (2.1-4.1)	.0001

AK, above knee; *BK,* below knee; *CI,* confidence interval; *HR,* hazard ratio.
[a]Includes patients who could not ambulate or who ambulated only with an assist device, such as a cane or walker.

Patients presenting with CLI in the setting of good functional status, who ambulate independently and live independently, should be offered LEB, and our study as well as the work of others predicts that such patients will likely remain ambulatory and live independently. However, the challenge lies in determining optimal treatment for the patient with poor ambulatory ability, nonindependent living status, advanced age, and worrisome anatomy for long-term graft patency. This answer is much less clear. Some argue that primary amputation should be considered in this setting.[13] However, amputation has a very low long-term survival rate and results in poor patient functional status.[25-27] Others argue that aggressive attempts at endovascular intervention should be used in these patients,[28] given their poor risk for peripheral bypass surgery and the dismal outcomes with primary amputation.

The role of endovascular interventions in the treatment of CLI is evolving, however, and utilization, enthusiasm, and results have varied over time.[29,30] Future studies of the functional outcome of alternative strategies, such as primary amputation or advanced endovascular strategies in patients with CLI, are needed. As the Medicare population ages and health care costs continue to rise, vascular surgeons must be certain to offer efficacious and cost-effective

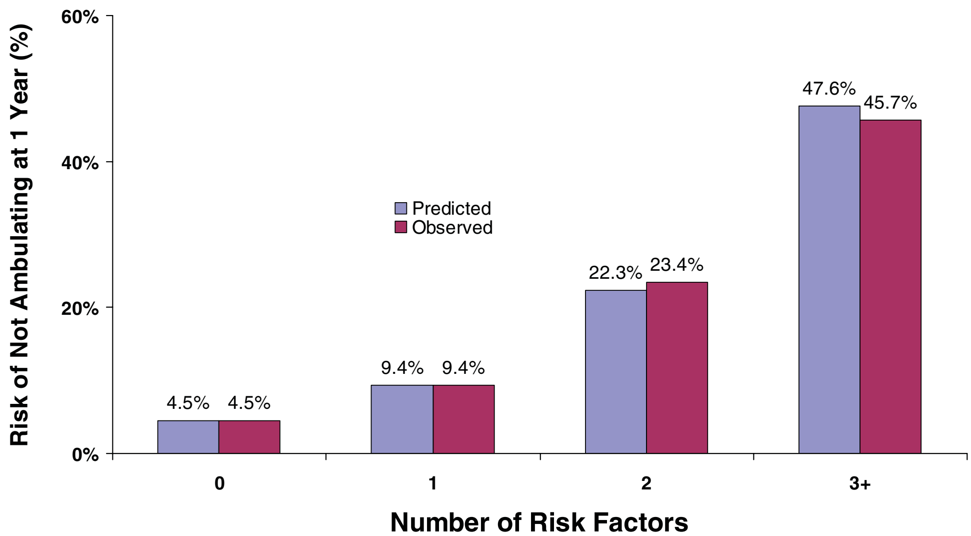

Fig 4. Risk of not ambulating at 1 year is shown by number of risk factors present. The *light bars* represent the predicted value from the model, and the *dark bars* represent the actual observed values.

Table III. Multivariate predictors of failure to ambulate among survivors with critical limb ischemia at 1 year after lower extremity bypass

Variable	*HR (95% CI)*	P
Preoperative		
Nonambulatory status[a]	1.7 (1.4-1.8)	.0001
Age		
60-69	1.9 (0.9-4.1)	.123
70-79	2.3 (1.1-4.7)	.026
80-89	3.5 (1.6-7.8)	.002
Nursing home residence	3.5 (1.5-7.8)	.003
Postoperative		
Graft thrombosis	1.6 (1.1-1.8)	.03
Major amputation	9.8 (4.2-22.6)	.0001

CI, Confidence interval; *HR,* hazard ratio.
[a]Includes patients who could not ambulate or who ambulated only with an assist device, such as a cane or walker.

interventions to patients in this dilemma, with demonstrable benefit in functional outcomes that matter to patients, providers, and payers alike.

Certain patient risk factors of age, nonambulatory status, and major amputation predicted 1-year survival and ambulation as well as 1-year ambulation alone. However, we found that two factors predictive of ambulation alone—graft thrombosis and preoperative nursing home residence—were not multivariate predictors of survival and ambulation. This finding reinforced our suspicion that certain factors, such as graft patency and patient functional status, are more closely correlated with ambulatory status than overall survival. Second, we were also pleased to note that although vascular surgeons have been criticized for their focus on graft patency, rather than functional outcomes, our results indicate that in fact these results were highly correlated.

Our work has limitations. First, no information was available for 9% of our patients for ambulation status at long-term follow-up. We cannot be certain that those patients lost to follow-up are not systematically different than those patients in whom follow-up was available 1 year after surgery. However, it is important to note that even in a worst-case scenario, wherein all patients with incomplete follow-up were nonambulatory, our results would still be comparable with several other series outlined in Table IV.

Second, our study was not a randomized trial adjudicated by impartial observers. It relied on surgeons and research personnel to accurately self-report outcomes in the context of a regional quality-improvement database. Although this is true, the data reported to the VSGNNE database are subject to audit using administrative and clinic-level data, and our audits demonstrated a 99% accuracy in capturing the LEB procedure itself and the outcomes of interest, such as discharge location.[15]

Third, our risk models use data from both preoperative and postoperative variables to allow the most accurate prediction of ambulation status 1 year after surgery. Although only a portion of these variables will be evident to the surgeon preoperatively, we believed it was important that surgeons were informed of all the measurable influences on the functional outcomes, regardless of when a particular event occurred.

Finally, our study includes patients with claudication and CLI, and some may argue that these two populations are too different to include side by side in a study where the main outcome measure is ambulatory status. However, we believe it is of value to report the ambulation status of both groups, especially because little has been reported in regards to the long-term ambulation rates of claudicant patients.

Table IV. Studies analyzing predictors of ambulation status after lower extremity bypass surgery

Study (first author)	*Year*	*Patients, No.*	*Study type*	*Post-op status[a]*		*Risk factors for nonambulation*
				Ambulation	*Living at home*	
Abou-Zamzam[22]	1998	513 (CLI)	Retrospective single-center series	99% at 6 mon	97% at 6 mon	Pre-op ambulatory status, independent living status
Chung[23]	2006	334	Retrospective series, 2 tertiary centers	72% at 6 mon	91% at 6 mon	Forefoot necrosis, graft patency (univariate only)
Taylor[24]	2007	331	Retrospective single-center series	86% at 1 y	NA	Impaired ambulation at presentation, infrainguinal disease, dialysis, gangrene, hyperlipidemia
VSGNNE	2008	1400	Prospective multicenter registry	92% at 1 y	93% at 1 y	Independent ambulation, pre-op nursing home status, CLI, age >70, post-op MI, major amputation

CLI, critical limb ischemia; *MI,* myocardial infarction; *NA,* not applicable; *VSGNNE,* Vascular Study Group of Northern New England.
[a]Rates are among surviving patients.

CONCLUSIONS

Patients with good functional status before LEB almost universally maintain ambulation and independent living status 1 year after surgery. Within our multivariate prediction model, we identified preoperative ambulatory status or living in a nursing home, CLI, increasing age >70 years, postoperative MI, and major amputation as predictive of death or being nonambulatory at 1 year. Low-risk patients had excellent functional outcomes, but patients with several of these risk factors fared poorly. Surgeons and patients should consider these variables to inform decision making when considering surgery in high-risk settings.

In addition, we believe surgeons can use these risk factors to design quality-improvement efforts aimed at improving the functional outcome of LEB. Real-world changes guided by these risk factors might be clinical pathways designed to prevent MI, aggressive physical therapy to help patients maintain ambulatory status before and during their hospitalization for LEB, and wound care strategies designed to avoid major amputation. Implementation of these strategies might decrease the effect of the risk factors identified in our study and therefore offer the opportunity to achieve better functional outcomes in high-risk patients undergoing LEB.

AUTHOR CONTRIBUTIONS

Conception and design: PG, JC
Analysis and interpretation: PG, DL, JC
Data collection: PG, DL, JC
Writing the article: PG
Critical revision of the article: DL, JC
Final approval of the article: PG, DL, JC
Statistical analysis: PG, DL
Obtained funding: PG, JC
Overall responsibility: PG

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Appendix (online only). Remaining patient characteristics with non-significant univariate associations

		Unable to ambulate		
Variable	*Total*	*If variable not present*	*If variable present*	P
Patient characteristics				
Nonwhite race	2%	7%	5%	.646
Pre-op medication				
Statin	58%	7%	7%	.816
β-Blocker	80%	8%	8%	.668
Operative variables				
Origin				
External iliac	2%	8%	4%	.525
Profunda	3%	8%	3%	.21
SFA	16%	7%	10%	.107
BK popliteal	5%	7%	9%	.669
Recipient				
SFA	1%	7%	0%	.217
BK popliteal	32%	7%	8%	.702
Tibioperoneal trunk	3%	7%	8%	.928
Anterior tibial	11%	7%	9%	.5
Posterior tibial	10%	7%	6%	.486
Peroneal	6%	8%	9%	.775
Anesthesia type				
General anesthesia	71%	8%	7%	.495
Epidural	10%	8%	6%	.472
Spinal	19%	7%	9%	.177

BK, Below-knee; *SFA,* superficial femoral artery.